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RULES FOR SEED TESTING[1]

CONTENTS

INTRODUCTION

The rôle of seed testing is to aid agriculture in avoiding one of the hazards of crop production. This should involve information to the crop producer as to the potential ability of his seed to produce a good crop of the desired plants and information that will aid in the control of the quality of planting seed offered for sale. In all such informational work it is important that the various workers should follow such procedure as will insure comparable results. It is obviously necessary to have definite directions for carrying on the work. These directions should always aim to obtain the potential value of the seed in crop production.

In the part which follows, directions that are essential for uniformity and accuracy of results and which should be considered definite rules are printed in type of this size (10 point), and directions which are chiefly designed to help the analyst to overcome special difficulties and which may be considered chiefly informational are printed in smaller (8 point) type.

THE SAMPLE

No matter how accurately a seed analysis is made, it can show only the quality of the sample submitted for analysis. Every effort should be made to insure that the sample sent to the analyst shall represent the bulk of seed in question.

1. WEIGHT OF SAMPLE TO BE SUBMITTED FOR ANALYSIS

The following are minimum weights of samples to be submitted for an analysis:

(*a*) Two ounces of grass seed not otherwise mentioned, white or alsike clover, or seeds not larger than these.

[1] Adopted by the Association of Official Seed Analysts of North America at the annual meeting at Ithaca, N. Y., August 17–20, 1926.

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(*b*) Five ounces of red or crimson clover, alfalfa, rye grasses, brome grasses, millet, flax, rape, or seeds of similar size.

(*c*) One pound of cereal, vetches, or seeds of similar or larger size.

If the sample is to be examined for origin at least five times the quantities here specified should be submitted.

2. METHOD OF TAKING THE SAMPLE

The sample must be taken in such a way that it represents as accurately as possible the bulk lot being sampled. To this end it is important that equal quantities be taken from each container sampled, and from each place in a container, in a given lot of seed.

(*a*) Bags, closed or open, should be sampled—

(1) With a trier or bag sampler long enough to reach the center of the bag; in small lots, approximately equal quantities should be taken from near the top, the middle, and the bottom of each bag; but when more than five bags are sampled, it should be sufficient to take from one place in each bag sampled (see 4); or

(2) With a long trier or probe which should extend the length of the bag.

(*b*) Bulk seeds in bins, cars, or other containers are to be sampled with a long trier or probe extended through the bulk in several places.

(*c*) In the case of packet seeds, take entire packets.

3. ALTERNATIVE METHODS

When better means are not available, open bags of cereals or other large seeds, or seeds in small bins or other packages may be sampled by hand, taking approximately equal quantities from different places including the top and opposite sides as near the bottom as practicable. Any portion of seed which has been opened and exposed for sale should be considered as liable to contamination and should be sampled with special care.

4. NUMBER OF BAGS TO BE SAMPLED

In lots of five bags or less, each bag should be sampled. In larger lots, sample every fifth bag, but never less than five bags. Whenever there is evidence of lack of uniformity in a lot of seed, each bag should be sampled separately.

The samples from each bag may be kept separate or they may be combined in composite samples as circumstances require.

5. DIVIDING THE SAMPLE

The total quantity of seed drawn may be in excess of that required for a sample. It is very important that the seeds should be thoroughly mixed before taking the sample that is to be sent for analysis; if possible a mechanical divider should be used to obtain the desired quantity.

THE ANALYSIS

It is obvious that not all samples received will require the same attention. Some samples are submitted for special information about some single feature of the sample. For such work, any method may be used that will give the desired information. However, if a complete analysis is desired, or if an official test is being made, the rules should be followed in detail.

THE WORKING SAMPLE

The sample submitted usually is, and should be, larger than is practicable for use in the actual determination. Great care should be taken that the working sample represents the material sent for analysis.

An efficient mechanical divider or sampler should be used to reduce the size of the sample. After mixing, the sample should be repeatedly divided until a portion is obtained of the approximate size recommended for the analysis. All of this portion should be considered the "working sample" and should be used for the purity analysis. In a complete analysis, the seeds for germination are taken from the pure-seed separation of this same working sample. Where germination only is required, the sample should be divided in the same manner as above until approximately the required number of seeds is obtained; counts should be made indiscriminately from this portion.

THE PURITY ANALYSIS

1. WEIGHT OF WORKING SAMPLE

Approximately the following weights of seeds of the respective classes should be examined. For any kind of seed not listed, use a quantity that will give approximately 3,000 seeds.

The relative size of the seeds of various crop plants is indicated in Table 1.

(*a*) One gram: *Agrostis* spp.; *Poa* spp.; Rhodes grass; Bermuda grass.

(*b*) Two grams: Timothy; orchard grass; fescues (excepting meadow fescue); meadow foxtail; alsike and white clover; carrot.

(*c*) Five grams: Rye grasses (Lolium); meadow fescue; foxtail millet; alfalfa; red clover; sweet clovers.

(*d*) Ten grams: Awnless brome grass; crimson clover; *Brassica* spp.; flax.

(*e*) Twenty-five grams: Proso millet; Sudan grass.

(*f*) Fifty grams: Sorghums; buckwheat; beet.

(*g*) One hundred grams: Vetches and cereals.

(*h*) Five hundred grams: Corn; beans; peas; cowpeas; soy beans.

It may be desirable to take two working samples of one-half the size given above and make the purity analysis on each part separately.

Noxious Weeds.—The determination of the number of seeds of individual noxious weeds present per unit weight should be made on the entire sample, or at least on the following minimum quantities for the various classes of seeds listed above: (*a*) 25 grams; (*b*) 50 grams; (*c*) 50 grams; (*d*) 50 grams; (*e*) 150 grams; (*f*) 300 grams; (*g*) 500 grams.

In the case of noxious weeds, it is important to have an accurate expression of the number present, even though they occur in very small proportions. For reasonable accuracy it is necessary to examine a sample of such size that a fair number of the noxious weeds will be found. Obviously, the actual size of the sample used should vary inversely with the number of noxious weed seeds present.

TABLE 1.—*Number of crop seeds per unit weight*

Kind of seed	Approximate number of seeds per gram [1]	Minimum weight for purity analyses (grams)	Approximate number of seeds in working sample
Alfalfa	500	5	2,500
Barley	30	100	3,000
Beet	54	50	2,700
Bent grass	18,000	1	18,000
Bermuda grass	3,940	1	3,940
Blue grass, Canada	5,500	1	5,500
Blue grass, Kentucky	4,800	1	4,800
Brome grass, awnless	300	10	3,000
Buckwheat	45	50	2,250
Carrot	900	2	1,800
Clover, alsike	1,500	2	3,000
Clover, crimson	330	10	3,300
Clover, red	600	5	3,000
Clover, sweet	570	5	2,850
Clover, white	1,500	2	3,000
Crested dog's-tail	1,900	2	3,800
Fescue, meadow	500	5	2,500
Fescue, red	1,200	2	2,400
Fescue, sheep	1,500	2	3,000
Fescue, hard	1,250	2	2,500
Flax	300	10	3,000
Meadow foxtail	1,200	2	2,400
Meadow grass, rough-stalked	5,600	1	5,600
Millet, foxtail	470	5	2,350
Millet, proso	180	25	4,500
Oats	28	100	2,800
Orchard grass	1,150	2	2,300
Rape, winter	230	10	2,300
Redtop	11,000	1	11,000
Rye	40	100	4,000
Rye grass, Italian	500	5	2,500
Rye grass, English	500	5	2,500
Rye grass, short-seeded	700	5	3,500
Sorghum, amber	55	50	2,750
Sorghum, kafir	50	50	2,500
Sudan grass	120	25	3,000
Sweet vernal grass	1,600	2	3,200
Tall oat grass	330	10	3,300
Timothy	2,500	2	5,000
Turnip	340	10	3,400
Velvet grass	2,500	2	5,000
Vetch, hairy	36	100	3,600
Vetch, spring	19	100	1,900
Western rye grass (Agropyron)	330	10	3,300
Wheat	25	100	2,500

[1] These numbers are based on tables given in the following publications:

DORPH-PETERSEN, K. BERETNING FRA STATSFRØKONTROLLEN. Copenhagen. 1922. (Average of 10 years' results.)

GROSS, E. GRUNDREGELN DES FUTTERBAUES. 23 p. Leipzig. 1897.

JENSSEN, C. UNTERSUCHUNGEN ÜBER DEN KULTURWERTH DER HANDELS-SAATEN UNSERER GEWÖHNLICHSTEN KLEE- UND GRASARTEN. Landw. Jahrb. 8:136, 170–173. 1879.

MUNN, M. T. RULES FOR SEED TESTING. N. Y. State Agr. Exp. Sta. Circ. 73, 15 p. 1924.

NOBBE, F. HANDBUCH DER SAMENKUNDE. 631 p., illus. Berlin. 1876.

STEBLER, F. G., and VOLKART, A. DIE BESTEN FUTTERPFLANZEN. Ed. 4, v. 1. Berlin. 1913.

Miss E. F. Sirrine, Washington, D. C., and F. T. Wahlen, Ottawa, Canada, furnished data where no published information was available.

2. IDENTITY OF SAMPLE

The sample should always be examined to determine (whenever such determination is possible) whether the seeds have been sent under a correct name. Any discrepancy should be noted and reported.

It must be recognized, of course, that varietal identity can usually be determined only by the culture of the plants.

3. ORIGIN OF SEED

To the farmer, a knowledge of the place of production of seed may be fully as important as a statement of its impurities or vitality; therefore any definite indications as to origin should be reported.

Since any conclusion about the origin of a particular lot of seed usually can be based only on the agreement of various indications obtained by the critical study of the incidental matter in a large sample, any statement concerning the actual place of production should not go beyond the evidence secured.

4. SEPARATION

The working sample should be weighed and then separated into four parts: (1) Pure seed; (2) other crop seeds; (3) weed seeds; (4) inert matter.

These four component parts should each be weighed in grams to the third decimal place, and the percentage by weight of each part (based on the sum of the weights of the component parts and not on the original weight) should be determined and recorded. In the case of other crop seeds and weed seeds the seeds of each species should be separated where possible and the number or weight of each kind recorded.

The sum of the weights of the component parts should be compared with the original weight of the working sample as a check against loss of material or other error.

The aid of an air blast, sieves, or other mechanical means should be utilized wherever it will facilitate the work without impairing its accuracy.

Where conditions require only an approximation of some component parts, or where special information is desired, the method of separation may be varied to suit the needs.

5. DEFINITIONS

(*a*) *Pure seed.*—All seeds of the kind under consideration should be considered pure seed, whether shriveled, cracked, or otherwise injured: *Provided*, (1) That in case of broken seeds, any piece larger than one-half should be considered pure seed, while pieces that are one-half or less should be considered inert matter; and (2) that decorticated seeds of legumes should be considered inert matter.

(*b*) *Other crop seeds.*—Seeds of plants locally grown as crops, other than the kind under consideration, should be considered other crop seeds unless designated as weed seeds.

(*c*) *Weed seeds.*—Seeds of plants recognized by laws or official regulations or by general usage as weeds should be considered weed seeds.

Individual seeds of Juncus may be included with the inert matter, except where bunches of seeds large enough to be removed readily with forceps are found. However, the presence of Juncus seeds should be recorded and reported with the weed seeds.

Universally accepted distinctions are not possible between weed seeds and crop seeds, since a plant species may be a harmful weed in one section and a useful crop plant in another. Those plants that are considered crop plants should be listed by each seed laboratory.

(*d*) *Inert matter.*—Broken seeds when one-half or less, decorticated seeds of legumes, dirt, stones, chaff, fungous bodies (such

as ergot and other sclerotia and smut balls), and any other matter not seeds should be considered inert matter; *Provided*, (1) That in the case of grasses, empty glumes should be considered inert matter and only glumes containing caryopses (grains) considered pure seed; and (2) that attached sterile glumes of grasses should be considered inert matter and should be separated from fertile glumes.

With some grasses (e. g., Rhodes grass), where the separation of the sterile glumes would involve an excessive amount of work, this procedure may be omitted, but the report should indicate such variation from the rules.

The presence or absence of caryopses may be determined by pressing each glume between forceps or between the finger nail and the table, or by the aid of transmitted light as with a mirror box.

6. ADULTERATED SAMPLES

Since seeds used as adulterants closely resemble the seeds with which they are mixed, the separation of the pure seed and the adulterant in the entire working sample may be slow and tedious. In such cases a shorter method may be permitted, as follows:

In making the separation, include the adulterant with the pure seed. From the mixture of pure seed and adulterant count out 1,000 seeds indiscriminately. In this lot of 1,000 seeds separate the adulterant and determine the percentage of each part by weight. When the seeds are similar in weight, an approximation may be made from the proportional number of seeds of each.

7. DUPLICATE ANALYSES

When a purity analysis indicates that a law has been violated or that a label is incorrect, one or more additional analyses should be made and the average of all analyses used.

GERMINATION TESTS

The reason for testing seeds for germination is to determine their ability to develop into normal plants under favorable conditions. Seed-control stations and seed-testing laboratories in different countries have developed various laboratory methods for testing each particular kind of seed that give satisfactory results under their own conditions. It does not seem practicable, therefore, to make hard and fast rules for germination, but rather it seems best to give the results of this past experience of satisfactory practice as the best present guide for making germination tests.

1. SOURCE OF SEEDS FOR GERMINATION

Seeds for germination are to be taken from the pure-seed separation if a purity analysis has been made. When only the germination of a sample is desired, the pure seed may be selected from the bulk if the purity approaches 98 per cent or more. In samples of lower purity a separation and computation of pure seed should be made and the seeds for germination should be taken from such pure-seed separation. When the seed for germination is taken from the original sample received, this sample should be divided with a mechanical sampler to obtain the approximate number of seeds needed for the test. In any case the seeds used for germination should be counted without discrimination as to size or condition.

2. NUMBER OF SEEDS AND DUPLICATE TESTS

In all cases where the results are to be compared with other tests at least 400 seeds from a sample should be tested for germination. In order to have a check on the uniformity of germination conditions, these seeds should be used in four tests of 100 seeds each.

Variations in results between duplicate tests may be due either to natural variations in sampling resulting from the use of a comparatively small number of seeds or to incomplete germination of one of the tests. Where the variation between duplicate tests is 10 per cent or greater, lack of uniformity in germination conditions should be suspected and a retest should be made. All results should be averaged, excepting only those that are obviously inaccurate.

3. LABORATORY GERMINATION—GENERAL CONDITIONS

Although the greenhouse soil test has many advantages in testing the ability of seeds to develop into plants, the demands of space and time generally make a more or less arbitrary artificial method of germination necessary for routine work. In making the laboratory tests and in interpreting their results it should always be kept in mind that the ultimate purpose of a germination test is to determine in the sample under test the percentage of seeds capable of developing normal seedlings.

Moisture, aeration, and temperature are the controlling factors in the germination of most seeds. The means of obtaining suitable conditions for germination may well be varied to suit local needs, but the general requirements for germination should always be kept in mind.

(*a*) *Substrata.*—A substratum should be selected that will supply the needed moisture and yet allow sufficient aeration. Convenience and ease of counting should also be considered. The following substrata are the most generally useful:

(1) For the smaller seeds, use *blue blotting paper*, 120 pounds to the ream, absorbent in quality, free from injurious chemicals and soluble dyes, cut 6 by 9 inches, and folded once. Very fine seeds, those with a mucilaginous coat, or those that would not otherwise receive sufficient aeration should be placed on top of the blotters; other kinds of seeds should be placed between the folds of the blotter.

(2) For larger seeds, use *paper toweling* of an absorbent grade. The seeds should be placed between the folds of the moist substratum. These larger seeds require more water, and the less rigid substratum allows a greater area of contact with the seeds. Canton flannel may also be used as a substratum for the larger seeds.

(3) For peas, beans, corn, and similar seeds, it is often advantageous to use *sand* or *soil* in the laboratory. Moisture is uniformly supplied and the spread of molds is greatly lessened. Small cardboard boxes with drainage holes in the bottom are very convenient for soil tests in the laboratory. A clean sand or a sandy soil should be used, and it should be moistened to about 70 per cent of its water-holding capacity.

(*b*) *Moisture.*—There is danger that in supplying moisture the aeration of the seeds will be restricted. The substratum should be kept moist enough at all times to supply the needed moisture to the seeds, but should never be so wet that a film of water forms around the seeds. Some kinds of seeds (e. g., spinach, pepper, and beet) are very sensitive to an excess of water.

(*c*) *Temperature.*—The provision of suitable temperature conditions is one of the most critical factors for satisfactory laboratory germination of many kinds of seeds. It is not necessary that any specific uniform temperature be maintained, but that certain general temperature conditions be provided. In some cases, the temperature requirements for germination can be secured without special equipment, but as a general rule laboratory germination requires artificial control of the temperature. The requirements of most germination work will be covered by two temperature conditions:

(1) A fairly uniform low temperature (18 to 20° C.), to be used for those seeds that are liable to be delayed in germination by temperatures above 20° C.

(2) An alternation between a low temperature (18 to 20° C.) for about 18 hours and a higher temperature for about 6 hours; used for those seeds that will germinate more readily with a sharp fluctuation of temperature and

also for those which, although not requiring such alternation, are not inhibited by the higher temperature. The higher temperature should be near 30° C. for most seeds, although a few kinds germinate better when the higher temperature is 35° C. In the use of alternating temperatures, the best effect is obtained by a sharp change of the temperature such as is secured when the tests are transferred between chambers maintained at all times at their respective temperatures. When lower temperatures than those specified are used, germination will be slower and a longer time must be allowed for the completion of the test.

(*d*) *Special treatments and forcing agents.*—It is desirable at times to hasten the completion of germination or to insure uniformity of conditions. Special treatment of the seeds to be used for germination may be of advantage.

(1) *Soaking.*—Some kinds of seeds (e. g., wrinkled peas) require so much water for germination that it is not readily supplied from the substratum. In such cases soaking is advisable, but care must be taken not to soak so long as to cause injury to germination or at a temperature above that to be used for germination.

(2) *Prechilling.*—Freshly harvested cereals and some other seeds are benefited if the first few days of germination takes place at a temperature of 5 to 10° C. The germination can be completed at the usual temperature.

(3) *Drying.*—After-ripening of freshly harvested seeds is often markedly hastened by drying to the normal moisture content. A temperature not above 40° C. is desirable, and free circulation of air should be provided.

(4) *Light.*—A number of kinds of seeds will germinate quicker and more completely if exposed to light during germination. The light exposure may be obtained by placing the tests in a window, by the use of artificial light, or by the aid of a daylight germinator, but in any case it is very important that the correct temperature conditions be maintained along with the light exposure.

(5) *Potassium nitrate.*—It has been found that the kinds of seeds benefited by light are also greatly hastened in germination if the substratum is moistened with a dilute solution of potassium nitrate. A potassium-nitrate solution made by dissolving 2 grams of the salt in 1 liter of water should be used for this purpose. Of commercial seeds, completion of germination is hastened by KNO_3 in the case of Canada bluegrass and Bermuda grass.

Where any special treatment is used to hasten germination, the treatment used should be mentioned in the report.

(*e*) *Special apparatus.*—(1) *Bell jar.*—Candle-drip glass is covered with blotting paper or other suitable substratum to hold the seeds. The substratum is kept moist with a wick which extends down into a supply of water. The test is covered by a small "bell jar," provided with an aperture for ventilation, that fits on the candle-drip glass and prevents undue evaporation when the test is exposed to light. Many modifications of the original Jacobsen apparatus or bell-jar method are in use; for example, the Copenhagen apparatus.

(2) *Petri dishes.*—Another method of obtaining suitable moisture during exposure to light is by the use of petri dishes such as are used in bacteriological work. Blotting paper, filter paper, or other suitable substratum is placed in the bottom of the dish, thoroughly wet, and then drained of all excess moisture before the seeds are put in place. Care is required to maintain correct moisture conditions in petri dishes.

(*f*) *Placing the seeds.*—Care should be taken that the seeds are uniformly spaced on the substratum, and that the seeds are given enough room to prevent contact during germination.

4. GREENHOUSE SOIL TESTS

Since the laboratory tests must be made under essentially artificial conditions, it is often desirable, where the results of such tests are in doubt, that supplementary tests should be made under the more natural conditions offered by the greenhouse. In greenhouse testing, experience and judgment must be the guide even more than in other germination work. Since it is impossible to obtain a standard soil for such work, it is best to be guided by the general requirements for germination.

A soil should be selected that will supply sufficient water to the seeds without hindrance to aeration and that will not bake. An equal mixture of good garden loam and sand (free from weed seeds) furnishes a suitable soil. The temperature of the greenhouses must be kept within the range that is suitable for the germination of the seeds being tested. In most cases satisfactory greenhouse tests are not practicable during the hot summer months. In order that abnormal seedlings may be detected, the seedlings in greenhouse soil tests should not be disturbed until germination is completed.

5. COUNTING GERMINATED SEEDS

In laboratory tests the seedlings should be counted and removed at frequent intervals. This facilitates the work and prevents interference with the moisture supply of the seeds that have not yet germinated. The usual times for making counts are suggested in Table 2.

(*a*) *Interpretation.*—Variation in the interpretation of the test is probably the most frequent cause of discrepancy in seed germination results. It is impossible to make a satisfactory definition of a seedling. The presence of a normal sprout and of a root with root hairs is a valuable indication, but the condition and vigor of the seedling, whether it is an early or a late germination, and general experience must also be guides. Since we wish to obtain as a result of the germination test the percentage of seeds capable of developing into normal seedlings, only such seeds should be counted as germinated which may reasonably be expected to continue their development under favorable conditions. It is suggested that we should interpret the laboratory test to correspond with the probable result in soil.

(*b*) *Broken seedlings.*—Seedlings of legumes that have both cotyledons broken or have a broken hypocotyl should not be counted as germinated. Where broken seedlings are evident, it is desirable to give a longer time for both the preliminary and the final counts, so that the broken seedlings can be determined.

(*c*) *Hard seeds.*—In laboratory tests seeds which remain hard at the end of the test because they have not absorbed water should be counted and reported as "hard seeds."

(*d*) *Disease.*—Any definite indications of diseased seeds, general lack of vigor, or other information of interest to the grower should be noted and reported.

6. DURATION OF TESTS AND RETESTING

It is convenient to have a schedule indicating the length of time that a given kind of seed usually requires for germination. Such a schedule is given in Table 2, but when the temperature falls below that indicated in the table the duration of the test must be extended. Differences in the previous history of the seeds or unsuspected variation of the germination conditions may cause delay in the germination of viable seeds. In such cases additional time should be given for the completion of germination.

Frequently a test will be encountered in which a portion of the seeds have remained sound and yet have not germinated during the usual duration of the test. In cases of this kind the sample should be retested under a variety of conditions, as may be indicated by the experience of the analyst. This type of behavior is often found in freshly harvested seeds, but it is also frequently encountered when such an explanation is not possible. If at the time of the preliminary count the appearance of the test is unusual, retests should be started at once.

7. SUGGESTED PROCEDURE FOR SPECIFIC SEEDS

Although many problems in the germination of seeds are not completely solved, the general requirements are known for the germination of the seeds of most crop plants. These general requirements are indicated in Table 2 in the suggested conditions of germination for each kind of seed. Good judgment and experience should in all cases be the guide in carrying out these suggestions.

TABLE 2.—*Suggested procedure for germination tests*

Kind of seed	Substratum [1]	Temperature (° C.) [2]	Usual duration of test	
			Preliminary count (days)	Final count (days)
Field crops:				
Barley [3]	B	20	3	5
Beans	T, S	20–30	3	6
Beet [4,5]	B	20–30	4	10
Buckwheat	B	20–30	3	5
Corn	T, S	20–30	3	5
Cotton [6]	T, S	20–30	4	7
Flax	TB	20–30	2	5
Hemp	B	20–30	3	5
Oats [3]	B	20	3	5
Peas	T, S	20	4	8
Rice	B	20–30	3	6
Rye [3]	B	20	3	5
Tobacco	TB	20–30	7	14
Wheat [3]	B	20	3	5
Wheat, durum [3]	B	20	4	6
Forage plants:				
Alfalfa	B	20	3	5
Bermuda grass [7]	BJ	20–35	10	21
Bluegrass, Canada [7]	BJ	20–30	14	28
Bluegrass, Kentucky	BJ, TB	20–30	14	28
Brome grass	B	20–30	5	10
Carpet grass	BJ	20–35	10	21
Clover, alsike	B	20	3	5
Clover, crimson	B	20	3	5
Clover, Japan	B	20–35	6	14
Clover, red	B	20	3	5
Clover, sweet	B	20	3	5
Clover, white	B	20	3	5
Cowpeas	T, S	20–30	4	10
Crested dog's-tail	B	20–30	10	18
Bent grass	BJ	20–30	10	21
Dallas grass	BJ	20–35	10	21
Fescues (except meadow)	B	20–30	10	21
Fescue, meadow	B	20–30	5	10
Meadow foxtail	B	20–30	6	10
Millet	B	20–30	3	5
Johnson grass	B	20–35	6	10
Orchard grass	B	20–30	6	14
Paspalum	B	20–35	6	14
Rape	B	20	3	5
Redtop	TB	20–30	5	10
Rescue grass	BJ	20–35	10	21
Rhodes grass	B	20–30	6	10
Rye grass	B	20–30	6	10
Sorghum	B	20–30	3	5
Sudan grass	B	20–30	3	5

[1] B=between blotters; TB=on top of blotters; T=between folds of absorbent paper towels or of Canton flannel; S=sand or soil boxes; BJ=bell jar or other modification of Jacobsen apparatus such as Copenhagen apparatus or petri dishes.

[2] Where two temperatures are given (as 20–30° C.) the test should be alternated between the given temperatures. It does *not* mean that the temperature may fluctuate within these limits.

[3] Freshly harvested cereals that do not germinate readily by the usual method should be germinated at 15° C. or by the prechilling method; i. e., the test should be kept in an ice box for three to five days, and then the test should be completed at room temperature.

[4] Soak in water at 20° C. for two hours before testing for germination.

[5] It is recommended that the germination of beet be confined to the determination of the percentage of balls which sprout.

[6] Samples of cottonseed from the Southwest, when tested by this method, often decay badly although the seed can be shown to have a high viability. When this condition is suspected supplementary germination tests should be made by thoroughly wetting the fuzz of the seed before putting it to germinate. If the supplementary test is higher than the standard test, report both standard germination and live seed (as indicated by the result of the supplementary test).

[7] The test should be exposed to light for a portion of the day (3 to 8 hours). Also complete germination is hastened markedly by moistening the substratum with a 0.2 per cent solution of potassium nitrate.

TABLE 2.—*Suggested procedure for germination tests*—Continued

Kind of seed	Substratum	Temperature (° C.)	Usual duration of test	
			Preliminary count (days)	Final count (days)
Forage plants—Continued.				
Soybeans	T, S	20–30	4	8
Sweet vernal grass	B	20–30	6	14
Tall oat grass	B	20–30	6	10
Timothy	TB	20–30	5	8
Turnip	B	20	3	5
Velvet grass	B	20–30	6	10
Vetch	T, S	20	4	14
Vegetables:				
Asparagus	T	20–30	6	14
Beans	T, S	20–30	3	6
Beet [4, 5]	B	20–30	4	10
Cabbage	B	20	3	5
Carrot	B	20–30	6	14
Cauliflower	B	20	3	5
Celery	B	20–30	10	21
Cucumber	B	20–30	3	5
Eggplant	TB	20–30	8	14
Kale	B	20	3	5
Lettuce [5]	B	20	2	4
Muskmelon	B	20–30	3	5
Okra	T	20–30	4	14
Onion	B	20	5	10
Parsley	B	20–30	14	28
Parsnip	B	20–30	6	21
Peas	T, S	20	3	6
Pepper	TB	20–30	4	10
Pumpkin	T	20–30	3	6
Radish	B	20	3	5
Salsify	T	20–30	5	10
Spinach	TB	20	5	10
Squash	T	20–30	3	6
Sweet corn	T, S	20–30	3	5
Tomato	B	20–30	4	10
Turnip	B	20	3	5
Watermelon	B	20–30	4	6
Flowers: [9]				
Ageratum	TB	20–30	6	10
Aster	B	20	5	12
Alyssum	TB	20	5	10
Balsam (Impatiens)	B	20	3	5
California poppy	B	20	4	12
Calendula	B	20	3	10
Candytuft	TB	20	3	8
Coreopsis	B	20	5	10
Cosmos	B	20	3	10
Hollyhock	B	20	5	16
Larkspur [10]	B	15	8	21
Morning glory	B	20–30	5	14
Mignonette	B	20	4	10
Nasturtium	T	15	7	10
Pansy	TB	20	6	12
Petunia	TB	20–30	5	10
Poppy	TB	15	5	10
Portulaca	TB	20	3	8
Snapdragon	TB	20	6	10
Summer cypress (Kochia)	TB	20–30	3	6
Sunflower	B	20–30	6	14
Sweet pea	T	20	5	10
Zinnia	B	20–30	4	8

[4] Soak in water at 20° C. for two hours before testing for germination.

[5] It is recommended that the germination of beet be confined to the determination of the precentage of balls which sprout.

[8] Soak for two hours in water not above 20° C. Some samples remain dormant with the usual treatment; these may be germinated by the prechilling method, or they may be placed on moist absorbent cotton in petri dishes.

[9] There is available a longer list of flowers giving the best information available on methods of germination.

[10] May also be germinated by the prechilling method, as noted in footnote 3.

EVALUATION AND REPORTS

After the purity analysis and the germination test have been made, there still remains the task of evaluating the results and making the reports.

1. TOLERANCE

Owing to the natural variation between samples from the same bulk, various analyses of the same lot of seed will fluctuate around the true value for the entire bulk. When comparing the results of two or more analyses, a certain amount of variation is to be expected. For this reason it is advisable to recognize a "tolerance" or permissible variation between an analysis or test and the given or supposedly true value.

The tolerance formula is to be applied to the given analysis or test.

(*a*) *Purity tolerance.*—For each determination the sample shall be considered as made up of two parts: (1) The component being considered, and (2) the balance of the sample. The tolerance in per cent allowed for each component shall be two-tenths of 1 per cent (0.2 per cent) plus 20 per cent of the lesser of the two parts..

(*b*) *Germination tolerance.*—A larger and more arbitrary tolerance must be allowed in the results of germination tests. Until more reliable information is available, the following tolerances should be allowed between a given germination and the result of the germination test:

Given germination (per cent)	Allowable variation (per cent)
90 or over	6
80 or over but less than 90	7
70 or over but less than 80	8
60 or over but less than 70	9
Less than 60	10

2. HARD SEEDS

In reporting the germination of seeds a portion of which remain hard at the end of the test, the actual percentage of germination should be reported and also the percentage of seeds remaining hard.

3. REPORTS

All reports should show the date of receipt of the sample, the serial test number, the sender's identification mark, and the common name of the seed.

(*a*) *Purity analysis report.*—This should show the percentage by weight of the pure seed, the percentage by weight of other crop seeds, the percentage by weight of weed seeds, and the percentage by weight and character of the inert matter. The quantity of each important foreign seed present should be shown, and special attention should be called to the seeds of all noxious weeds, or such information as is required by law to be given with seed offered for sale where the report is issued. Any other information regarding the value of the seed, such as the possibility of improvement by recleaning, should be given.

(*b*) *Germination test report.*—This should include the duration of the germination test, the average percentage of germination, and the percentage of hard seeds if any. Any special condition, such as delayed germination, weak vitality, watery or diseased sprouts, or insect damage, should be mentioned in the report. Any special or unusual treatment used in making the germination test should be noted on the report.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

January 10, 1927

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